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In re application off	)	
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Michael Stirm	)	Docket No. P-US-PR1044
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Serial No. 09/826,841	)	Group Art Unit: 3721
	)	
Filed: April 6, 2001	)	Examiner: N. C. Chukwurah
	)	
For: ROTARY HAMMER	)	

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

In the Office Action dated 12/30/02, a request was made for a certified copy of the priority document for this application. Accordingly, we are enclosing a certified copy and Express Mailing receipt.

A full response to the Office Action will be forwarded to you in a timely manner.

Respectfully submitted,

Michael P. Leary

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January 23, 2003

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I HEREBY CERTIFY THAT THIS CORRESPONDENCE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE AS FIRST CLASS MAIL IN AN ENVELOPE ADDRESSED TO: COMMISSIONER FOR PATENTS WASHINGTON, DC 20231 ON: 1.23.2003

Patricia Martin Patricia Martin

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I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

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Dated 20th March 2001

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Request for grant of a patent

07 APR 2000

The Patent Office
Cardiff Road
Newport
Gwent NP9 1RH

1	Your reference	**P-UK-PR1044**
2	Patent application number	**0008465.7**
3	Full name, address and postcode of the applicant	Black & Decker Inc Drummond Plaza Office Park 1423 Kirkwood Avenue Newark, Delaware, 19711, USA
	Patents ADP number	34121 4001
	State of incorporation	U S A, Delaware
4	Title of the invention	Rotary Hammer Mode Change Mechanism
5	Name of agent	**Heather Regan** Black & Decker Patent Department 210 Bath Road Slough SL1 3YD
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6	Priority applications	Country / Priority App No / Date of Filing

7	Parent application (eg Divisional)	Earlier Application No	Date of Filing
8	Statement of Inventorship Needed?	Yes	
9	Number of sheets for any of the following (not counting copies of same document)		
	Continuation sheets of this form		
	Description	14	
	Claims	5	
	Abstract	1	
	Drawings	4 +4	
10	Number of other documents attached		
	Priority documents		
	Translations of priority documents		
	P7/77		
	P9/77	1	
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	Other documents	Covering letter, Fee Sheet	

11 I/We request the grant of a patent on the basis of this application.

Signature 06 April 2000

12	Name and daytime telephone number of person to contact in the United Kingdom	Ms Heather Regan 0161 427 7005

ROTARY HAMMER MODE CHANGE MECHANISM

The present invention invention relates to a mode change mechanism for a rotary hammer and in particular to a mode change mechanism switchable using a single mode change actuator for switching the hammer between a hammer only mode, a rotary drive only mode and a rotary hammering mode. In the hammer only mode a bit inserted in a tool holder of the hammer is repeatedly struck by a hammering mechanism and is not rotatably driven. In the rotary drive only mode a bit inserted in the tool holder is rotatably driven and is not subject to impacts from the hammering mechanism. In the rotary hammering mode a bit inserted into the tool holder is repeatedly struck by a hammering mechanism and is simultaneously rotatably driven.

Such hammers generally comprise a spindle mounted for rotation within the hammer housing which can be driven in rotation by a rotary drive arrangement which can be selectively engaged and disengaged with a pinion driven by a motor of the hammer. The spindle rotatingly drives a tool holder of the hammer which in turn rotatingly drives a tool or bit releaseably secured within it. Within the spindle is generally slideably located a piston which is reciprocatingly driven by a hammer drive mechanism which translates the rotary drive of the motor to a reciprocating drive of the piston. A ram, also slideably located within the spindle, forwardly of the piston, follows the reciprocation of the piston due to successive over and under pressures in an air cushion within the spindle between the piston and the ram. The ram repeatedly impacts a beatpiece slideably located within the spindle forwardly of the ram which transfers the forward impacts from the ram to a tool or bit releasably secured, for limited reciprocation, within the tool holder at the front of the hammer. The mode change mechanisms for such hammers can selectively engage and disengage the rotary drive to the spindle and the reciprocating drive to the piston.

Mode change mechanisms are known in which a single mode change actuator is used to switch the hammer between its different modes. However, they tend to be relatively complex, have parts which are intricate and/or difficult to manufacture cheaply in bulk in a robust manner that can withstand sustained use of the hammer and/or are relatively difficult to assemble.

One known arrangement is described in US 5,159,986. This document discloses a mode change arrangement which comprises a mode change knob having a first cam element for activating and de-activating hammering and a second cam element for activating and

de-activating rotary drive (with the added feature that two drive speeds can be selected). The first cam element can in a first position block rearward movement of the spindle which prevents the drive from being transmitted to the hammer drive arrangement. In a second position of the first cam element rearward movement of the spindle occurs when a tool or bit held in the tool holder of the hammer is pressed against a working surface. This rearward movement of the spindle engages two coupling parts to allow drive to be transmitted from the intermediate shaft to the hammer drive arrangement. The second cam arrangement is used to guide an adjustment element along a rod mounted in the housing of the hammer, which adjustment element engages the spindle drive gears to shift them between three positions. In a first position drive gear engages a spindle lock to prevent rotation of the spindle, which position is co-ordinated with a position of the first cam surface such that drive is transmitted to the hammer drive arrangement. In a second position the first drive gear engages the intermediate shaft to drive the spindle at a first speed of rotation and in a third position the second drive gear engages the intermediate shaft to drive the spindle at a second speed. The three positions of the drive gears, ie. the orientation of the second cam element, are co-ordinated with the blocking and non-blocking positions, ie the orientation of the first cam element, in order to co-ordinate the activation of the spindle at the required speed with the activation of hammering. It can be seen that the arrangement in US 5,159,986 requires many non-standard type parts such as the first and second cam surfaces, the adjustment element and bearing and cage which have to interact to change between modes. Such parts are relatively expensive to manufacture in such a way that they can survive sustained use of the hammer and still provide smooth changes between different modes of the hammer. It will also be appreciated that assembly of such an arrangement is relatively difficult again adding cost to the manufacture of such hammers. US 5,159,986 does not address the problem of mis-alignment of the gears or teeth when the gears or teeth are shifted into a position in which they must mesh. Accordingly, additional parts, such as biasing means acting between the knob and the adjustment element (41) will be required to bias the gears or teeth into their meshing position until one of the gears has rotated enough to allow meshing to occur, adding additional cost and complexity.

The present invention provides a simple and reliable mode change arrangement for changing between hammer only mode, rotary hammer mode and rotary drive only mode which can utilise primarily standard engineering parts such as splined shafts, gear wheels, splined sleeves and springs which are cheap to manufacture in a robust manner

and relatively easy to assemble.

According to the present invention there is provided a rotary hammer, comprising;

an intermediate shaft which is rotatingly driven by a motor of the hammer when power is supplied to the motor,

a spindle which can be driven in rotation about its axis by the intermediate shaft via a spindle drive means,

a tool holder arranged for rotation with the spindle for releasably holding a bit or tool such that the bit or tool can reciprocate,

a pneumatic hammering arrangement located within the spindle which can repeatedly impact a bit or tool held within the tool holder, said pneumatic hammering arrangement comprising a piston which can be reciprocatingly driven by a hammer drive arrangement which can translate rotary drive from the intermediate shaft to a reciprocating drive to the piston, and

a mode change arrangement for changing the operation of the hammer between a rotary drive only mode, a hammer only mode and a rotary hammer mode, said mode change arrangement comprising a single actuator switchable by a user of the hammer between the three modes,

characterised in that the mode change arrangement comprises a spindle driving sleeve rotatable on the intermediate shaft for driving the spindle drive means, a hammer driving sleeve rotatable on the intermediate shaft for driving the hammer drive arrangement and a mode change sleeve, which preferably surrounds the intermediate shaft, and which is permanently driven by and shiftable along the intermediate shaft, and the switching of the actuator by a user shifts the mode change sleeve along the intermediate shaft between three positions, such that in a first rotary drive only position the mode change sleeve transmits rotary drive to the spindle driving sleeve to transmit rotary drive to the spindle drive means, in a second hammer only position the mode change sleeve transmits rotary drive to the hammer driving sleeve to transmit rotary drive to the hammer drive arrangement, and in a third rotary hammer position the mode change sleeve transmits rotary drive to the spindle driving sleeve and to the hammer driving sleeve to transmit rotary drive to the spindle drive means and to the hammer drive arrangement.

By mounting the hammer drive sleeve and the spindle drive sleeve rotatably on the intermediate shaft and by mounting a mode change sleeve shiftably and non-rotatably

along the intermediate shaft, the mode change sleeve can be used to transfer rotary drive from the intermediate shaft to the hammer drive sleeve and/or the spindle drive sleeve by simply shifting the mode change sleeve along the intermediate shaft to selectively engage the hammer drive sleeve and/or the spindle drive sleeve. The parts required for this mode change arrangement are standard engineering parts, ie. a shaft and sleeves rotatable or non-rotatable on the shaft and optionally shiftable along the shaft, the sleeves having parts, such as gear wheels or teeth, which are selectively engageable with each other. Such parts can be manufactured cheaply and robustly and can be easily assembled to provide a simple and yet reliable mode change arrangement.

Preferably, an intermediate shaft driving means, preferably a gear, non-rotatable on the intermediate shaft is in permanent engagement with a mode change sleeve driven means, preferably a set of teeth, on the mode change sleeve so that rotation of the intermediate shaft rotatingly drives the mode change sleeve.

In a preferred arrangement, the hammer drive sleeve is located towards the rear of the mode change sleeve and has driven means, preferably a set of teeth, which are engageable with driving means, preferably a set of teeth, on the mode change sleeve to transmit rotary drive from the intermediate shaft to the hammer drive sleeve. Preferably, the mode change sleeve driven means which engage the intermediate shaft driving means are axially extended and also form the mode change sleeve driving means which are engageable with the hammer drive sleeve driven means to transmit rotary drive from the intermediate shaft to the hammer drive arrangement. Using a single extended driven and driving means, such as an extended set of teeth, simplifies the structure of the mode change sleeve.

In a preferred arrangement, the spindle drive sleeve is located towards the front of the mode change sleeve and has driven means, preferably a set of teeth, which are engageable with driving means, preferably a set of teeth, on the mode change sleeve to transmit rotary drive from the intermediate shaft to the spindle drive sleeve. Again, it is preferred that the mode change sleeve driven means which engage the intermediate shaft driving means are axially extended to also form the mode change sleeve driving means which are engageable with the spindle drive sleeve driven means to transfer rotary drive from the intermediate shaft to the spindle drive sleeve. Using a single extended driven and driving means, such as an extended set of teeth, again simplifies the structure of the

mode change sleeve.

When the above preferred arrangements are both used on the hammer, the mode change arrangement is arranged such that that in a first rotary drive only position the mode change sleeve is shifted to a forward position on the intermediate shaft to transmit rotary drive to the spindle driving sleeve via the mode change sleeve driving means and the spindle drive sleeve driven means, in a second hammer only position the mode change sleeve is shifted to a rearward position on the intermediate shaft to transmit rotary drive to the hammer driving sleeve via the mode change sleeve driving means and the hammer drive sleeve driven means and in a third rotary hammer position the mode change sleeve is shifted to an intermediate position on the intermediate shaft between the forward and the rearward positions and transmits rotary drive to the spindle driving sleeve and transmits rotary drive to the hammer driving sleeve.

In a preferred embodiment, the switching of the single actuator shifts the mode change sleeve via a mode change member. The mode change member may be mounted on a housing part of the hammer so as to be slideable in a direction substantially parallel to the intermediate shaft. The mode change member is preferably provided with a mode change arm, preferably a ring, which extends laterally of the mode change member, which mode change arm at least partly surrounds at least part of the mode change sleeve and is connected to the mode change sleeve such that shifting of the mode change member shifts the mode change sleeve via the mode change arm between its three positions.

In order to ensure transmission of rotary drive between parts which are not initially in meshing alignment when the hammer is first switched into one of its modes, a biasing arrangement is located between the actuator and the mode change sleeve in order to bias the mode change sleeve towards its position on the intermediate shaft which corresponds to the position to which the actuator is switched. When the hammer comprises a mode change member having a mode change arm as described above, it is preferred that the biasing arrangement comprises a first spring means located between a forward end of the mode change sleeve and a forward facing part of the mode change arm and a second spring means located between a rearward end of the mode change sleeve and a rearward facing part of the mode change arm.

Preferably, a spindle lock is provided on the hammer to lock the spindle against rotation when the hammer is in hammer only mode. When the hammer comprises a mode change member as described above it is preferred that the spindle lock comprises first locking means located on the mode change member which first locking means is engageable with second locking means provided on the spindle when the mode change member is shifted to a hammer mode only position to lock the spindle against rotation.

The actuator may be a rotatable knob mounted on a housing part of the hammer such that rotation of the knob rotates an eccentric pin which pin is slideably engaged with a slot in the mode change member in order to shift the mode change member to shift the mode change sleeve between its three positions.

The mode change arrangement described above is suited to the type of hammer having a pneumatic hammering arrangement which comprises a reciprocatingly driven piston which reciprocatingly drives a ram via a closed air cushion which ram repeatedly impacts a beatpiece which beatpiece transmits the forwards impacts from the ram to a bit or tool held in the tool holder. It is especially suited to the type of hammer in which the intermediate shaft is substantially parallel to the spindle.

It is preferred that the spindle drive sleeve comprises a driving means, preferably a gear, which is in permanent engagement with a driven means, preferably a gear, which is part of the spindle drive means.

It is also preferred that the hammer drive arrangement is a wobble plate drive arrangement.

Preferably, a releasable detent arrangement is provided for releasably latching the actuator in the required mode switch position. This is of special importance if the hammer comprises means for biasing the mode change mechanism into meshing engagement when meshing parts are initially mis-aligned.

One form of rotary hammer according to the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows a layout of the components of the rotary hammer mode change

mechanism according to the present invention;

Figure 2a shows a longitudinal cross section though the rotary hammer the components of which are shown in Figure 1, when the rotary hammer is in rotary drive only mode;

Figure 2b shows a longitudinal cross section though the rotary hammer the components of which are shown in Figure 1, when the rotary hammer is in rotary hammer mode; and

Figure 2c shows a longitudinal cross section though the rotary hammer the components of which are shown in Figure 1, when the rotary hammer is in hammer only mode.

Referring to the Figures a rotary hammer is shown having a forward housing part (2) and a central housing part (4) which are fixed together by screw members (not shown) to form a housing for the hammer spindle, spindle drive arrangement, hammer drive arrangement and mode change mechanism. A resilient housing seal (6) fits between the housing parts (2) and (4) in complementary recesses provided in the co-operating end surfaces of the housing parts (2) and (4) to form a seal between the housing parts. The housing parts (2) and (4) are each formed with a semi-circular recess (2a) and (4a) respectively which co-operate to form a circular recess, lined with a ring section (6a) of the housing seal (6), within which a mode change knob (8) is mounted for rotation about mode change axis (12). The mode change knob has an axle with an increased diameter portion (10) which is trapped within the hammer housing when the housing parts (2) and (4) are fitted together and in this way the mode change knob is secured to the hammer housing. The end of the mode change axle which extends into the hammer housing is provided with an eccentric pin (14) for slideably moving a mode change member (68) as will be described in more detail below.

The hammer has a spindle (18) which is mounted for rotation within the hammer housing (2,4) as is conventional. Within the rear of the spindle is slideably located a hollow piston (20) as is conventional. The hollow piston (20) is reciprocated within the spindle (18) by a hammer drive arrangement which is described in more detail below. A ram (21) follows the reciprocation of the piston (20) in the usual way due to successive

under-pressures and over-pressures in an air cushion within the spindle (18) between the piston (20) and the ram. The reciprocation of the ram causes the ram to repeatedly impact a beatpiece (22) which itself repeatedly impacts a tool or bit (not shown). The tool or bit is releasably secured to the hammer by a tool holder of conventional design, such as an SDS-Plus type tool holder (16), which enables the tool or bit to reciprocate within the tool holder to transfer the forward impact of the beatpiece to a surface to be worked (such as a concrete block). The tool holder (16) also transmits rotary drive from the spindle (18) to the tool or bit secured within it.

The hammer is driven by a motor not shown, which has a pinion (not shown) which rotatingly drives an intermediate shaft (24) via a drive gear (32). The intermediate shaft is mounted for rotation within the hammer housing (2, 4), parallel to the hammer spindle (18) by means of rearward bearing (26) and forward bearing (28). A spring washer (30) urges the intermediate shaft rearwardly and is used to damp any reciprocatory motion which is transmitted to the intermediate shaft (24) via the wobble plate hammer drive arrangement described below. The intermediate shaft has a driving gear (50) either integrally formed on it or press fitted onto it so that the driving gear rotates with the intermediate shaft (24). Thus, whenever power is supplied to the motor the driving gear (50) rotates along with the intermediate shaft (24).

The hammer drive arrangement comprises a hammer drive sleeve (34) which is rotatably mounted on the intermediate shaft (24) and which has a wobble plate track (36) formed around it at an angle to the axis of the intermediate shaft (24). A wobble plate ring (38) from which extends a wobble pin (40) is mounted for rotation around the wobble track (36) via ball bearings (39) in the usual way. The end of the wobble pin (40) remote from the wobble ring (38) is mounted through an aperture in a trunnion (42) which trunnion is pivotally mounted to the rear end of the hollow piston (20) via two apertured arms (44). Thus, when the hammer drive sleeve is rotatably driven about the intermediate shaft the wobble plate drive (36,38,39,40,42,44) reciprocatingly drives the hollow piston in a conventional manner. The hammer drive sleeve (34) has a set of driven splines (48) provided at the forward end of the sleeve (34). The driven splines (48) are selectively engageable with the intermediate shaft driving gear (50) via the mode change mechanism described below. When the intermediate shaft is rotatably driven by the motor pinion and the mode change mechanism engages the driving splines (48) of the hammer drive sleeve (34), the driving gear (50) rotatably drives the hammer

drive sleeve (34), the piston (20) is reciprocatingly driven by the wobble plate drive and a tool or bit mounted in the tool holder (16) is repeatedly impacted by the beatpiece (22) via the action of the ram (21).

The spindle rotational drive arrangement comprises a spindle drive sleeve (56) which is mounted for rotation about the intermediate shaft (24). The spindle drive sleeve comprises a set of driving teeth (60) at its forward end which are permanently in engagement with the teeth of spindle drive gear (62). The spindle drive gear (62) is mounted non-rotatably on the spindle (18) via drive ring (64) which has a set of teeth provided on its internal circumferential surface which are permanently engaged with a set of drive teeth (66) provided on the outer cylindrical surface of the spindle (18). teeth. Thus, when the spindle drive sleeve (56) is rotatably driven the spindle (18) is rotatably driven and this rotary drive is transferred to a tool or bit via the tool holder (16). The drive sleeve (36) has driven gear (58) located at its rearward end which can be selectively driven by the intermediate shaft driving gear (50) via the mode change mechanism.

The mode change mechanism which can be used to selectively actuate the hammer drive arrangement and/or the spindle drive arrangement comprises a mode change member (68) which is slideably mounted within the housing (2,4) on guide members (not shown) mounted within or formed integrally with the housing (2,4). The mode change member (68) has a set of spindle lock teeth (70) which can be selectively engaged with the spindle drive gear (62) to lock the spindle, via the drive gear (62) against rotation. The mode change member (68) has a mode change ring (72) secured to its central region so that the ring (72) extends laterally of the member (68). The mode change ring (72) is slideably mounted over a mode change sleeve (52). A pair of coil springs (76,78) are mounted surrounding the mode change sleeve (52) in order to position the mode change ring (72) with respect to the mode change sleeve (52). The forward spring (76) acts between an annular flange (84) located towards the forward end of the mode change sleeve (52) and the forward annular face of the mode change ring (72). The rearward spring (78) acts between the rearward annular face of the mode change ring (72) and a stop ring (80) which is mounted towards the rearward end of the mode change sleeve (52) by a snap ring (82). The mode change member (68) is formed with a slot (74) which extends in a direction substantially perpendicular to the direction of sliding of the mode change member (68). The eccentric pin (14) of the mode change knob (8) is

slideably received within the slot (74) in the mode change member (68) such that as the mode change knob (8) is rotated by a user of the hammer about its axis (12) the eccentric pin (14) slides along the slot (74) and causes the mode change member (68) to slide forwards or backwards within the housing (2,4) in order to move the mode change ring (72) forwards or backwards with respect to the intermediate shaft (24) and to move the spindle lock teeth (70) forwards or backwards with respect to the spindle drive gear (62).

A detent arrangement comprising a spring (90) and a ball bearing (92) is arranged in a bore (94) provided in the housing part (4) so that the ball bearing is urged by the spring into one of a number of pockets (not shown) provided in the underside of the knob (8). Each pocket is positioned on the underside of the knob (8) so that it corresponds to a mode position of the knob (8). When the knob (8) is moved between mode positions in order to change the operating mode of the hammer, a user must overcome the biasing force of the spring (90) to push the ball bearing (92) out of a relevant one of the pockets in the underside of the knob (8). Once the knob (8) is moved into the selected mode position the ball bearing (92) is urged by the spring (90) to engage a relevant one of the pockets in the underside of the knob (8) to latch the knob against movement out of the selected mode change position.

Figure 2a shows the hammer in rotary drive only mode in which the spindle (18) is driven rotationally and the hammer drive arrangement is disengaged. The mode change knob (8) is in the furthest position to which it can be rotated in a clockwise direction and so the eccentric pin lies forwardly of the axis (12) of the mode change knob (8) and maintains the mode change member (68) in its forward most position. In this position the spindle lock teeth (70) are located forwards of the spindle drive gear (62) and so the spindle drive gear (62) is free to rotate in order to rotationally drive the spindle (18). The mode change ring (72) is in its forwardmost position and urges the mode change sleeve (52) forwardly via spring (76) so that the mode change sleeve internal teeth (54) are disengaged from the hammer drive splines (48) on the hammer drive sleeve (34) and so that the mode change sleeve internal teeth (54) are engaged with the driving gear (50) on the intermediate shaft (24) and the driven gear (58) on the spindle drive sleeve (54). As the internal teeth (54) are disengaged from the hammer drive splines (48) rotation of the intermediate shaft (24) is not transmitted to the hammer drive sleeve (34) which remains stationary as the intermediate shaft (24) is rotated by the motor. Thus, no

hammering action occurs. However, the engagement of the internal teeth (54) of the mode change sleeve (52) with the intermediate shaft driving gear (50) and the spindle drive sleeve driven gear (58) transmits rotary drive from the intermediate shaft to the spindle drive sleeve (52). This rotary drive is then transmitted to the spindle via the driving teeth (60) on the spindle drive sleeve, the spindle drive gear (62) and the spindle drive ring (64). Accordingly, the hammer operates in rotary drive only or drilling only mode.

The hammer is moved into rotary drive only mode by rotating the mode change knob (8) clockwise and the knob (8) is latched it in its rotary drive only position by the detent arrangement (90,92). When the hammer is moved into rotary drive only mode from hammer only mode as the knob is rotated clockwise, it is possible that the internal teeth (54) of the mode change sleeve are not in alignment with the teeth of the spindle drive sleeve driven gear (58). If this is the case then as the mode change ring (72) is shifted forwardly and the forward movement of the mode change sleeve (52) is blocked by the mis-aligned teeth, the spring (76) is compressed and acts to urge the mode change sleeve (52) towards its forward most position. Thus, with the knob (8) latched in the rotary drive only position, as soon as the intermediate shaft (24) has rotated by the small angle required to align the internal teeth (54) with the teeth of the driven gear (58), the spring (76) pushes the mode change sleeve (52) forwardly into the position shown in Figure 2a so that the internal teeth (54) of the mode change sleeve and the spindle drive sleeve driven gear (58) mesh. Thereafter, rotation of the intermediate shaft (24) is transmitted to the spindle (18).

Figure 2b shows the hammer in rotary hammer mode in which the spindle (18) is driven rotationally and the hammer drive is engaged. The mode change knob (8) is in an intermediate position and so the eccentric pin lies above the axis (12) of the mode change knob (8) and maintains the mode change member (68) in an intermediate position. In this position the spindle lock teeth (70) are still located forwards of the spindle drive gear (62) and so the spindle drive gear (62) is free to rotate in order to rotationally drive the spindle (18). The mode change ring (72) is in an intermediate position and urges the mode change sleeve (52) into an intermediate position via spring (76) or (78) depending on the previous mode of operation of the hammer. In this intermediate position the drive sleeve internal teeth (54) are engaged with the hammer driven splines (48) on the hammer drive sleeve (34) and with the driven gear (58) on the

spindle drive sleeve (56). As the internal teeth (54) are engaged with the hammer driven splines (48) rotation of the intermediate shaft (24) is transmitted to the hammer drive sleeve (34) which rotates with the intermediate shaft (24). Thus, rotary drive from the motor is translated into a reciprocating drive of the hollow piston (20) via the intermediate shaft driving gear (50), the mode change sleeve (52) the hammer driven splines (48) on the hammer drive sleeve (34) and the wobble plate mechanism (36,38,39,40,42) and so hammering action occurs. The engagement of the internal teeth (54) of the mode change sleeve (52) with the intermediate shaft driving gear (50) and the spindle drive sleeve driven gear (58) transmits rotary drive from the intermediate shaft to the spindle drive sleeve (52). This rotary drive is then transmitted to the spindle (18) via the driving teeth (60) on the spindle drive sleeve, the spindle drive gear (62) and the spindle drive ring (64). Accordingly, the hammer operates in rotary hammer mode.

The hammer is moved into rotary hammer mode by rotating the mode change knob (8) either anti-clockwise from the rotary drive only position or clockwise from the hammer only mode position.

When the hammer is moved into rotary hammer mode from rotary drive only mode as the knob is rotated anti-clockwise, it is possible that the internal teeth (54) of the mode change sleeve are not in alignment with the driven splines (48) of the hammer drive sleeve (34). If this is the case then as the mode change ring (72) is shifted rearwardly and the rearward movement of the mode change sleeve (52) is blocked by the mis-aligned teeth, the spring (78) is compressed and acts to urge the mode change sleeve (52) towards its intermediate position. Thus, with the knob (8) latched in the rotary hammer position, as soon as the intermediate shaft (24) has rotated by the small angle required to align the splines (48) of the hammer driving sleeve (34) with the teeth of the mode change sleeve internal teeth (54), the spring (78) pushes the mode change sleeve (52) rearwardly into the position shown in Figure 2b so that the internal teeth (54) of the mode change sleeve and the splines (48) on the hammer drive sleeve (34) mesh. Thereafter, rotation of the intermediate shaft (24) is transmitted to the hammer drive arrangement as well as to the spindle drive arrangement.

When the hammer is moved into rotary hammer mode from hammer only mode as the knob is rotated clockwise, it is possible that the internal teeth (54) of the mode change

sleeve are not in alignment with the teeth of the spindle drive sleeve driven gear (58). If this is the case then as the mode change ring (72) is shifted forwardly and the forward movement of the mode change sleeve (52) is blocked by the mis-aligned teeth, the spring (76) is compressed and acts to urge the mode change sleeve (52) towards its intermediate position. Thus, with the knob (8) latched in the rotary hammer position, as soon as the intermediate shaft (24) has rotated by the small angle required to align the teeth of the spindle drive sleeve driven gear (58) with mode change sleeve internal driving teeth (54), the spring (76) pushes the mode change sleeve (52) forwardly into the position shown in Figure 2b so that the internal teeth (54) of the mode change sleeve and the teeth of the spindle drive sleeve driven gear (58) mesh. Thereafter, rotation of the intermediate shaft (24) is transmitted to the spindle drive arrangement as well as to the hammer drive arrangement.

Figure 2c shows the hammer in hammer only mode in which the spindle (18) is locked against rotation and the hammer drive arrangement is engaged. The mode change knob (8) is latched in the furthest position to which it can be rotated in an anti-clockwise direction and so the eccentric pin lies rearwardly of the axis (12) of the mode change knob (8) and maintains the mode change member (68) in its rearward most position. In this position the spindle lock teeth (70) are in engagement with the spindle drive gear (62) and so the spindle drive gear (62) and thus the drive the spindle (18) is locked against rotation.

In hammer only mode the mode change ring (72) is in its rearward most position and urges the mode change sleeve (52) rearwardly via spring (78) so that the drive sleeve internal teeth (54) are engaged with the hammer drive splines (48) on the hammer drive sleeve (34) and so that the drive sleeve internal teeth (54) are disengaged from the driven gear (58) on the spindle drive sleeve (54). As the internal teeth (54) are engaged with the hammer drive splines (48) rotation of the intermediate shaft (24) is transmitted to the hammer drive sleeve (34) which rotates with the intermediate shaft (24). This rotational drive to the hammer drive sleeve (34) is translated into a reciprocating drive for the piston (20) via the hammer drive arrangement (36,38,39,40,42). Thus, hammering action occurs. The disengagement of the internal teeth (54) of the mode change sleeve (52) from the spindle drive sleeve driven gear (58) means that no rotary drive is transmitted from the intermediate shaft to the spindle drive sleeve (56) which remains stationary as the intermediate shaft (24) rotates. Accordingly, the hammer

operates in hammer only mode.

The hammer is moved into hammer only mode by rotating the mode change knob (8) anti-clockwise. When the hammer is moved into hammer only mode from rotary drive only mode as the knob is rotated anti-clockwise, it is possible that the internal teeth (54) of the mode change sleeve are not in alignment with the driven splines (48) on the hammer drive sleeve (34). If this is the case then as the mode change ring (72) is shifted rearwardly and the rearward movement of the mode change sleeve (52) is blocked by the mis-aligned teeth, the spring (78) is compressed and acts to urge the mode change sleeve (52) towards its rearward most position. Thus, with the knob (8) latched in the hammer only position, as soon as the intermediate shaft (24) has rotated by the small angle required to align the internal teeth (54) with the driven splines (48) of the hammer drive sleeve (34), the spring (78) pushes the mode change sleeve (52) rearwardly into the position shown in Figure 2c so that the internal teeth (54) of the mode change sleeve and the driven splines (48) mesh. Thereafter, rotation of the intermediate shaft (24) is transmitted to the hammer drive sleeve (34).

CLAIMS

1. A rotary hammer, comprising;
an intermediate shaft (24) which is rotatingly driven by a motor of the hammer when power is supplied to the motor,
a spindle (18) which can be driven in rotation about its axis by the intermediate shaft (24) via a spindle drive means (62,64)
a tool holder (16) arranged for rotation with the spindle for releasably holding a bit or tool such that the bit or tool can reciprocate,
a pneumatic hammering arrangement (20,21,22) located within the spindle (18) which can repeatedly impact a bit or tool held within the tool holder, said pneumatic hammering arrangement comprising a piston (20) which can be reciprocatingly driven by a hammer drive arrangement (34,36,38,39,40,42) which can translate rotary drive from the intermediate shaft (24) to a reciprocating drive to the piston (20), and
a mode change arrangement for changing the operation of the hammer between a rotary drive only mode, a hammer only mode and a rotary hammer mode, said mode change arrangement comprising a single actuator (8) switchable by a user of the hammer between the three modes,
characterised in that the mode change arrangement comprises a spindle driving sleeve (56) rotatable on the intermediate shaft for driving the spindle drive means (62,64), a hammer driving sleeve (34) rotatable on the intermediate shaft (24) for driving the hammer drive arrangement (34,36,38,39,40,42) and a mode change sleeve (52) which is permanently driven by and shiftable along the intermediate shaft (24), and the switching of the actuator (8) by a user shifts the mode change sleeve (52) along the intermediate shaft (24) between three positions, such that in a first rotary drive only position the mode change sleeve (52) transmits rotary drive to the spindle driving sleeve (56) to transmit rotary drive to the spindle drive means (62,64), in a second hammer only position the mode change sleeve (52) transmits rotary drive to the hammer driving sleeve (34) to transmit rotary drive to the hammer drive arrangement (34,36,38,39,40,42), and in a third rotary hammer position the mode change sleeve (52) transmits rotary drive to the spindle driving sleeve (56) and to the hammer driving sleeve (34) to transmit rotary drive to the spindle drive means (62,64) and to the hammer drive arrangement (34,36,38,39,40,42).

2. A rotary hammer according to claim 1 characterised in that an intermediate shaft

driving means (50) non-rotatable on the intermediate shaft (24) is in permanent engagement with a mode change sleeve driven means (54) on the mode change sleeve (52) so that rotation of the intermediate shaft (24) rotatingly drives the mode change sleeve (52).

3. A rotary hammer according to claim 1 or claim 2 characterised in that the hammer drive sleeve (34) is located towards the rear of the mode change sleeve (52) and has driven means (48) which are engageable with driving means (54) on the mode change sleeve to transmit rotary drive from the intermediate shaft (24) to the hammer drive sleeve (34).

4. A rotary hammer according to claim 3 characterised in that the mode change sleeve driven means (54) which engage the intermediate shaft driving means (50) are axially extended to form the mode change sleeve driving means which are engageable with the driven means (48) on the hammer drive sleeve (34).

5. A rotary hammer according to any one of the preceding claims characterised in that the spindle drive sleeve (56) is located towards the front of the mode change sleeve (52) and has driven means (58) which are engageable with driving means (54) on the mode change sleeve (52) to transmit rotary drive from the intermediate shaft (24) to the spindle drive sleeve (56).

6. A rotary hammer according to claim 5 characterised in that the mode change sleeve driven means (54) which engage the intermediate shaft driving means (50) are axially extended to form the mode change sleeve driving means (54) which are engageable with the driven means (58) on the spindle drive sleeve (56).

7. A rotary hammer according to claim 5 or 6 when dependent on claim 3 or 4 characterised in that the mode change arrangement is arranged such that that in a first rotary drive only position the mode change sleeve (52) is shifted to a forward position on the intermediate shaft (24) to transmit rotary drive to the spindle driving sleeve (56) via the driving means (54) on the mode change sleeve (52) and the driven means (58) on the spindle drive sleeve (56), in a second hammer only position the mode change sleeve (52) is shifted to a rearward position on the intermediate shaft (24) to transmit rotary drive to the hammer driving sleeve (34) via the driving means (54) on the mode change

sleeve (52) and the driven means (48) on the hammer drive sleeve and in a third rotary hammer position the mode change sleeve (52) is shifted to an intermediate position on the intermediate shaft between the forward and the rearward position and transmits rotary drive to the spindle driving sleeve (56) via the driving means (54) on the mode change sleeve (52) and the driven means (58) on the spindle drive sleeve (56) and transmits rotary drive to the hammer driving sleeve (34) via the driving means (54) on the mode change sleeve (52) and the driven means (48) on the hammer drive sleeve.

8. A rotary hammer according to any one of the preceding claims characterised in that the switching of the single actuator (8) shifts the mode change sleeve (52) via a mode change member (68).

9. A rotary hammer according to claim 8 characterised in that the mode change member (68) is mounted on a housing part (2,4) of the hammer so as to be slideable in a direction substantially parallel to the intermediate shaft (24).

10. A rotary hammer according to claim 8 or claim 9 characterised in that the mode change member (68) has a mode change arm (72) extending laterally of it which mode change arm at least partly surrounds a part of the mode change sleeve (52) and is connected to the mode change sleeve (52) such that shifting of the mode change member (68) shifts the mode change sleeve (52) via the mode change arm (72) between its three positions.

11. A rotary hammer according to any one of the preceding claims characterised in that a biasing arrangement (76,78) is located between the actuator (8) and the mode change sleeve (52) in order to bias the mode change sleeve (52) towards the position on the intermediate shaft which corresponds to the position to which the actuator (8) is switched.

12. A rotary hammer according to claim 11 when dependent on claim 10 characterised in that the biasing arrangement comprises a first spring means (76) located between a forward end of the mode change sleeve (52) and a forward facing part of the mode change arm (72) and a second spring means (78) located between a rearward end of the mode change sleeve (52) and a rearward facing part of the mode change arm (72).

13. A rotary hammer according to any one of the preceding claims wherein a spindle lock (70) is provided to lock the spindle (18) against rotation when the hammer is in hammer only mode.

14. A hammer according to claim 13 when dependent on any one of claims 8 to 10 characterised in that the spindle lock comprises first locking means (70) located on the mode change member (68) which first locking means (70) engage second locking means (62,64) provided on the spindle when the mode change member (68) is shifted to a hammer mode only position to lock the spindle (18) against rotation.

15. A hammer according to any one of claims 8 to 10 characterised in that the actuator is a rotatable knob (8) mounted on a housing part (2,4) of the hammer and is arranged such that rotation of the knob (8) rotates an eccentric pin (14) which is slideably engaged with a slot (74) in the mode change member (68) in order to shift the mode change member to shift the mode change sleeve (52) between its three positions.

16. A hammer according to any one of the preceding claims wherein the pneumatic hammering arrangement comprises a reciprocatingly driven piston (20) which reciprocatingly drives a ram (21) via a closed air cushion which ram repeatedly impacts a beatpiece (22) which beatpiece transmits the forwards impacts from the ram to a bit or tool held in the tool holder (16).

17. A hammer according to any one of the preceding claims characterised in that the intermediate shaft (24) is substantially parallel to the spindle (18).

18. A hammer according to any one of the preceding claims characterised in that the spindle drive sleeve (56) comprises a driving means (60) which is in permanent engagement with a driven means (62) which is part of the spindle drive means (62,64).

19. A hammer according to any one of the preceding claims characterised in that the hammer drive arrangement is a wobble plate drive arrangement (36,38,39,40).

20. A hammer according to any one of the preceding claims characterised in that a releasable detent arrangement (90,92,94) is provided for releasably latching the actuator (8) in the required mode switch position.

21. A hammer substantially as hereinbefore described with reference to any one of the accompanying drawings.

ABSTRACT

ROTARY HAMMER MODE CHANGE MECHANISM

A rotary hammer, comprising an intermediate shaft (24) which is rotatingly driven by a motor of the hammer when power is supplied to the motor, a spindle (18) which can be driven in rotation about its axis by the intermediate shaft (24) via a drive means (62,64), a tool holder (16) arranged for rotation with the spindle for releasably holding a bit or tool such that the bit or tool can reciprocate and a pneumatic hammering arrangement (20,21,22) located within the spindle (18) which can repeatedly impact a bit or tool held within the tool holder. The pneumatic hammering arrangement comprises a piston (20) which can be reciprocatingly driven by a hammer drive arrangement (34,36,38,39,40,42) which can translate rotary drive from the intermediate shaft (24) to a reciprocating drive to the piston (20). A mode change arrangement is provided for changing the operation of the hammer between a rotary drive only mode, a hammer only mode and a rotary hammer mode, said mode change arrangement comprising a single actuator (8) switchable by a user of the hammer between the three modes. The mode change arrangement comprises a spindle driving sleeve (56) rotatable on the intermediate shaft which can rotatingly drive the spindle drive means (62,64), a hammer driving sleeve (34) rotatable on the intermediate shaft (24) for driving the hammer drive arrangement (34,36,38,39,40,42) and a mode change sleeve (52) which surrounds and is permanently driven by the intermediate shaft (24). The switching of the actuator (8) by a user shifts the mode change sleeve (52) along the intermediate shaft (24) between three positions, such that in a first rotary drive only position the mode change sleeve (52) transmits rotary drive to the spindle driving sleeve (56) to transmit rotary drive to the spindle drive means (62,64), in a second hammer only position the mode change sleeve (52) transmits rotary drive to the hammer driving sleeve (34) to transmit rotary drive to the hammer drive arrangement (34,36,38,39,40,42), and in a third rotary hammer position the mode change sleeve (52) transmits rotary drive to the spindle driving sleeve (56) and to the hammer driving sleeve (34) to transmit rotary drive to the spindle drive means (62,64) and to the hammer drive arrangement (34,36,38,39,40,42).

Figure 2a.

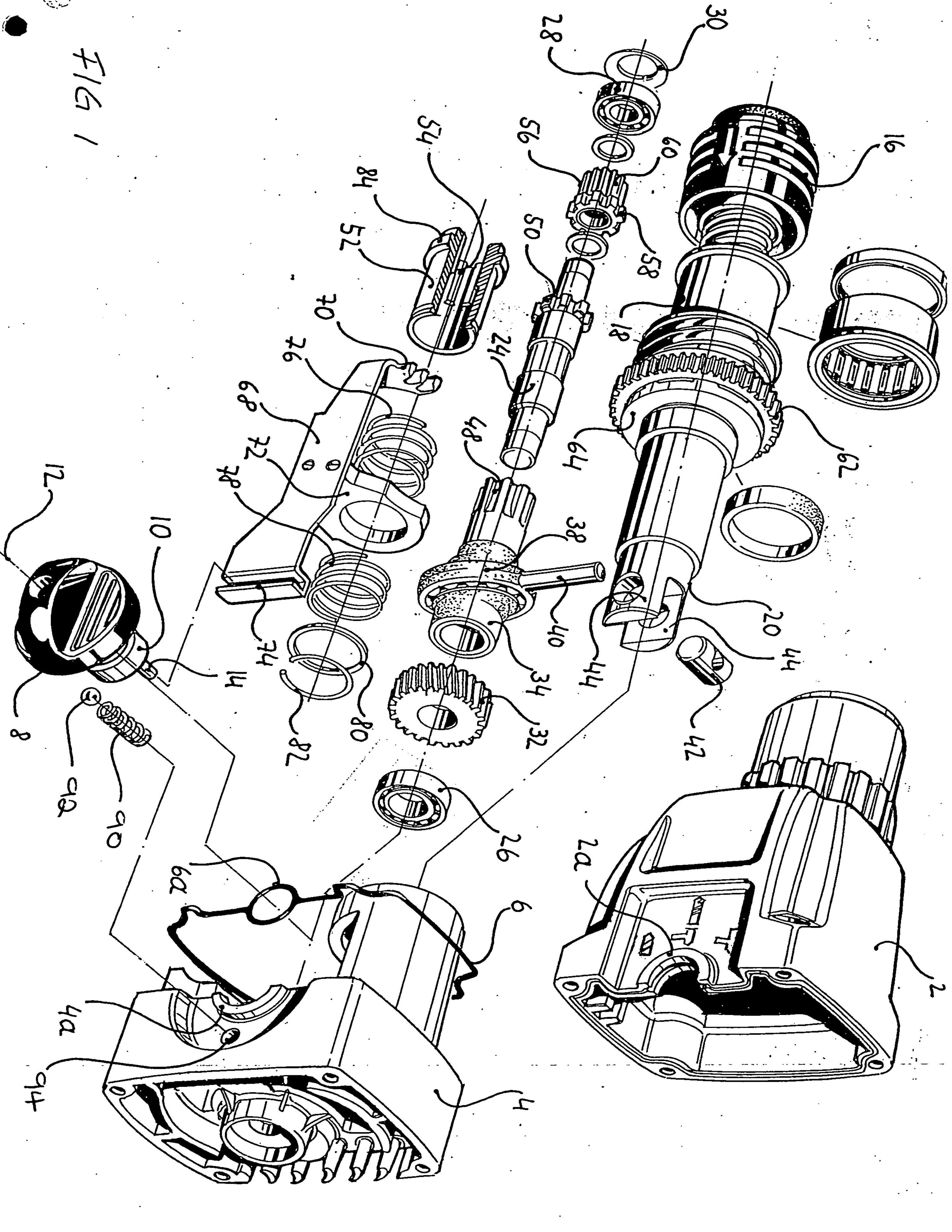

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FIG 1

FIG 2a

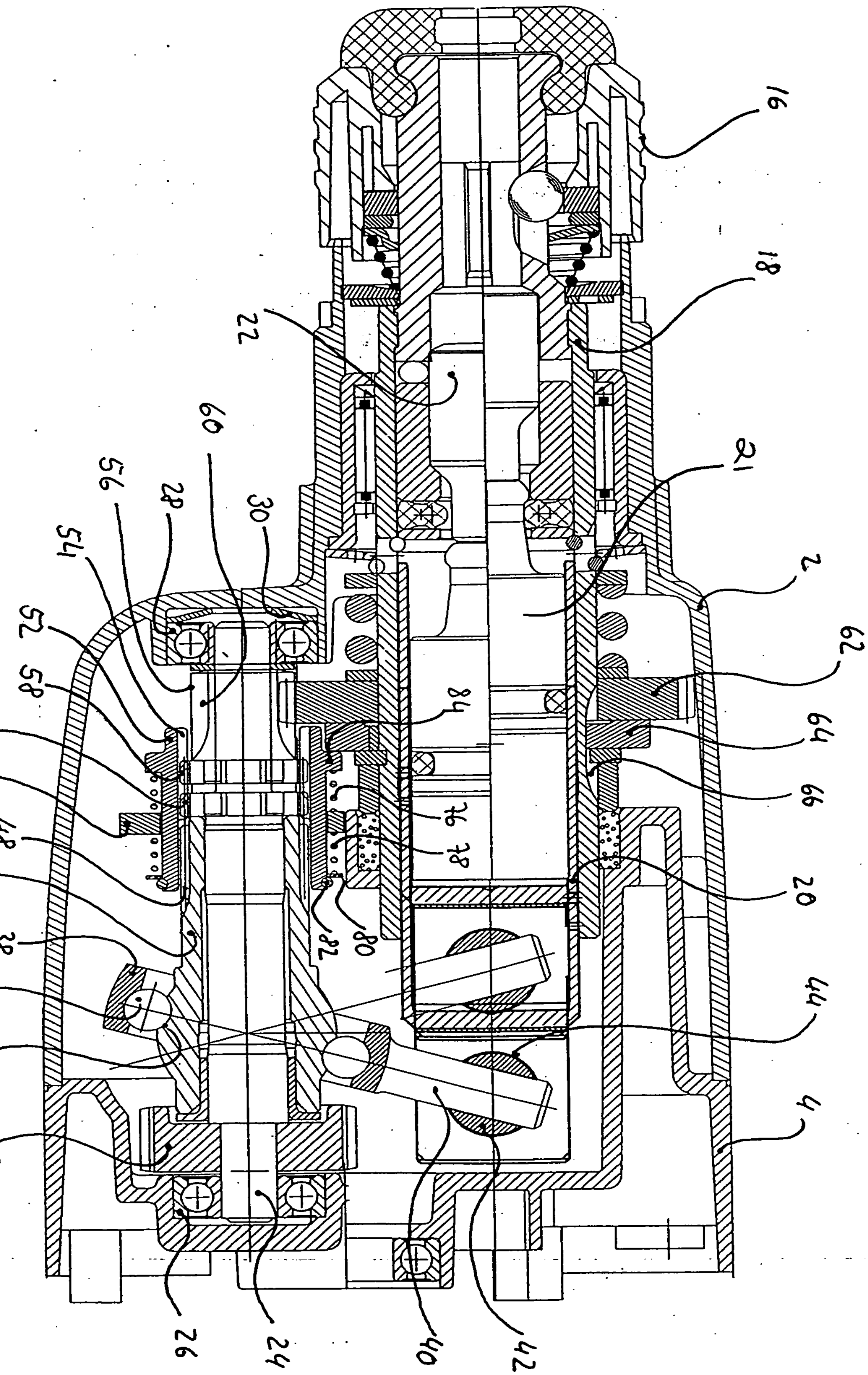
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FIG 2b

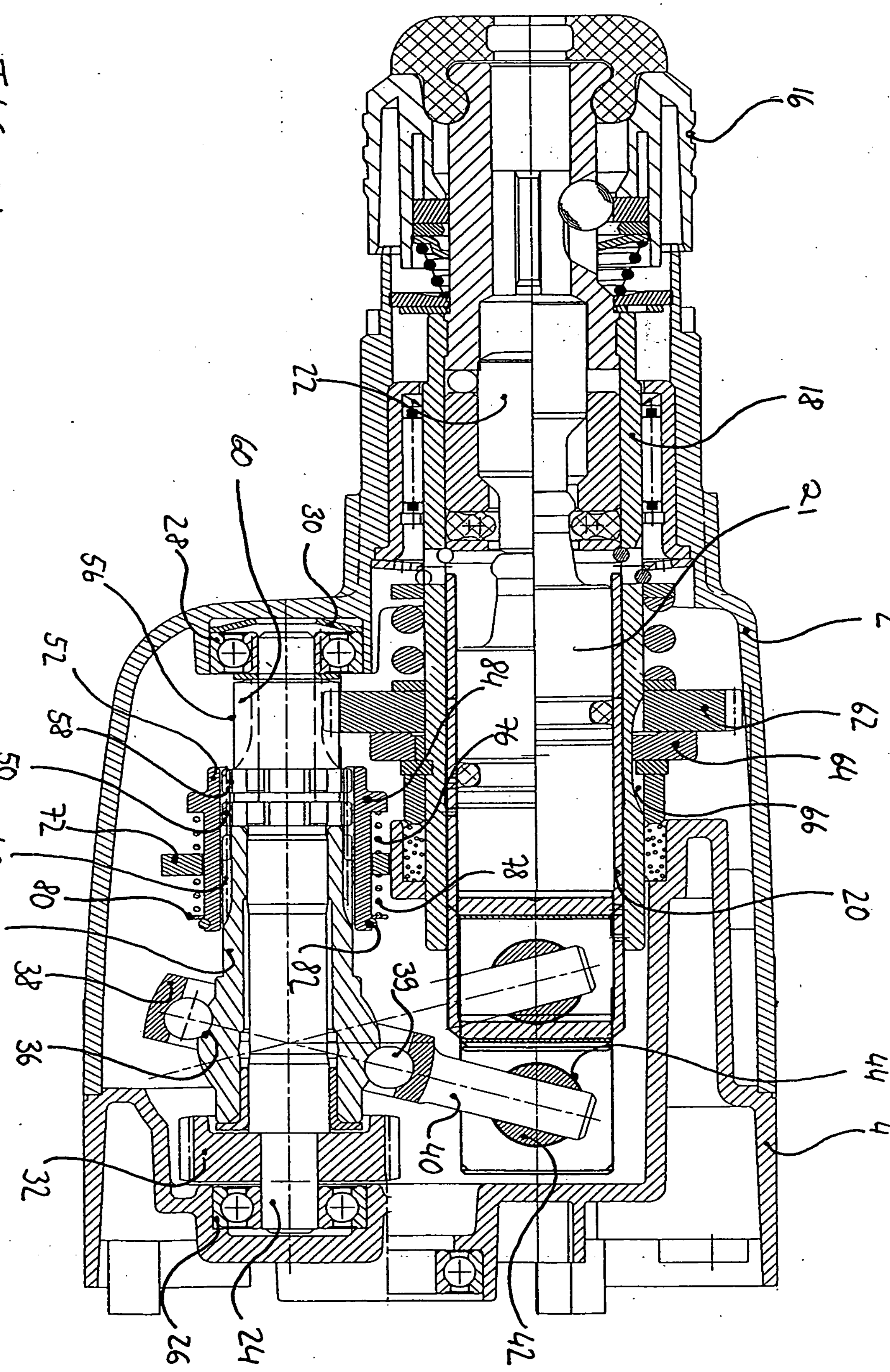
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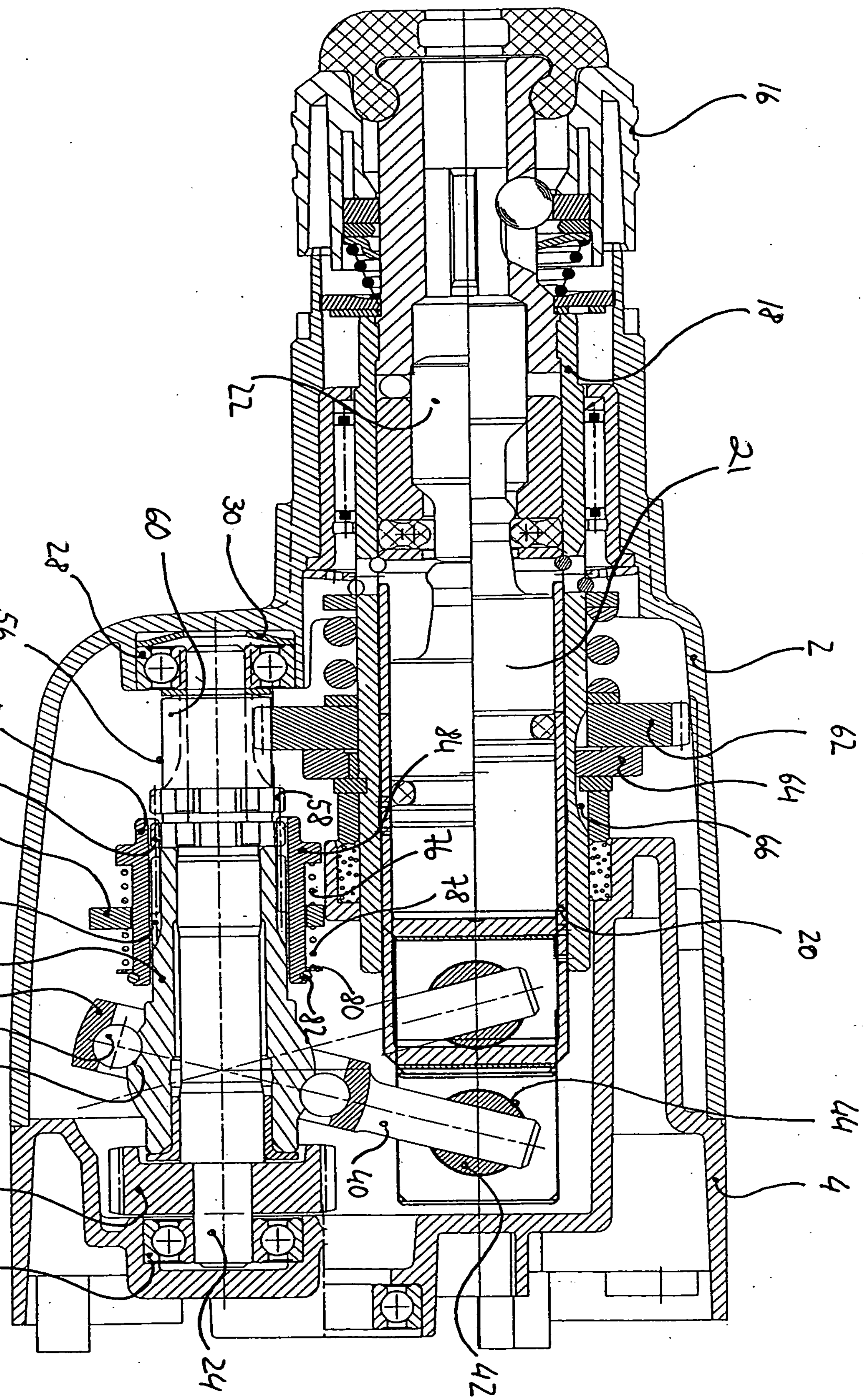
FIG 2C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